includes preparing water or a chemical solution containing a chelating agent [is] selected from the group consisting of NTA, EDTA, DTPA, CyDTA, salts thereof, and a mixture thereof.

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REMARKS

Reconsideration and allowance in view of the above amendment and the following remarks are respectfully requested. Claims 1-20 are pending in the application. By this amendment, claims 1-20 are being amended to improve their form. No new matter is involved.

In paragraph 1 on the second page of the Office Action, claims 1 and 2 are objected to because each claim should begin with "A." In response thereto, applicant is amending claims 1 and 2 to recite "A storage water" in place of "Storage water."

In paragraph 2 on the second page of the Office Action, claims 1-20 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite inasmuch as it is said that there is no method or manipulative steps recited in the claims. In this connection, applicant notes that claims 1 and 2 are apparatus claims. In response to the rejection of method claims 3-20, applicant is extensively amending such claims to define the various recitations therein, as much as possible, in terms of steps in accordance with the methods of the claims. For example, claim 3 which previously recited after the preamble thereof "wherein the silicon wafer is stored in water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination" is being amended to instead read

"comprising the steps of preparing water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination, and storing a silicon wafer in the prepared water or a chemical solution." As so amended, method claims 3-20 are submitted to be clear and definite.

In paragraph 3 which appears on the second page of the Office Action, claims 1 and 2 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The phrase "storage water" set forth in the claims is said to be indefinite. By way of explanation, applicant notes that the invention defined in each of claims 1 and 2 is not a container of any kind but is "storage water." Storage water is the water or chemical solution for storing a silicon wafer therein. If there is a waiting period between the polishing step and the subsequent cleaning step, a wafer may be stored in water during the waiting period. The reason for this is that if the wafer is allowed to stand in air, polishing slurry dries and adheres to the wafer. The adhered slurry is difficult to remove in the subsequent step. "Storage water" is the water used for the water storage, as described at lines 4-9 of page 2 of the specification. Therefore, the present invention does not relate to a "container" or the like for storing a wafer.

Conventionally, a surfactant is sometimes added to the storage water, and the wafer is usually stored while being immersed in water contained within a container, as described at lines 10-16 of page 2 of the specification. However, the wafer to be produced sometimes becomes defective because its oxide dielectric

breakdown voltage is degraded, as described at lines 11-16 of the page 3 of the specification. In accordance with the present invention, the causes of such degradation were analyzed, and it was found that such degradation is caused by a conventional method of storing a silicon wafer in a step before the cleaning step, as described at lines 5-10 of page 4 of the specification. Consequently, the present invention provides improvements in conventional "storage water."

In view of this, the reference to "storage water" in claims 1 and 2 is not indefinite.

In paragraph 4 on the third page of the Office Action, claims 1-7, 12, 13, 16, 17 and 20 are rejected under 35 U.S.C. § 102(b) as being anticipated by Kern. In paragraph 4 on the fourth page of the Office Action, claims 14, 15, 18 and 19 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Kern in view of Hayashida et al. In paragraph 5 on the fifth page of the Office Action, claims 8-11 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Kern in view of Prigge et al. These rejections are respectfully traversed.

Claim 1 as amended defines storage water in accordance with the invention as follows:

> 1. A storage water used for storage of a silicon wafer in water, wherein the storage water contains Cu at a concentration of 0.01 ppb or less [emphasis added].

Claim 3 as amended defines a method in accordance with the invention, as follows:

3. A method of storing a silicon wafer in water, comprising the steps of preparing water or a chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination, and storing a silicon wafer in the prepared water or a chemical solution [emphasis added].

Claim 4 as amended defines a method in accordance with the invention, as follows:

4. A method of storing a silicon wafer in water, comprising the steps of preparing storage water containing Cu at a concentration of 0.01 ppb or less, and storing a silicon wafer in the prepared storage water [emphasis added].

Claim 12 as amended defines a method in accordance with the invention as follows:

12. A method of storing a silicon wafer in a storage solution, comprising the steps of preparing water or a chemical solution containing a chelating agent, and storing a silicon wafer in the prepared water or chemical solution [emphasis added].

The features of the present invention, as defined in claims 1, 3, 4 and 12 involve storing a silicon wafer in storage water containing "Cu at a concentration of

0.01 ppb or less" (claims 1 and 4), water or a chemical solution "which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination" (claim 3), or "water or a chemical solution containing a chelating agent" (claim 12).

According to the features as set forth in claims 1, 3, 4 and 12, an object of the present invention is the provision of silicon wafer storage water and a silicon wafer storage method that can prevent contamination during storage to thereby prevent degradation of oxide dielectric breakdown voltage (see lines 19-23 of page 5 of the specification). For example, the present invention has the effect that in the case where a wafer is stored during a waiting period between the polishing step and the subsequent cleaning step, adhesion of polishing slurry which would otherwise occur when the wafer is left in air can be prevented, while preventing degradation of oxide dielectric breakdown voltage of the silicon wafer (see lines 10-18 of page 10 of the specification).

The Kern reference describes ultrapure water containing Cu at a concentration of 0.01 ppb or less (see Table 4 on pages 78 and 79) and of using EDTA chelating solution (see Fig. 1 and pages 30 and 31). Furthermore, Kern describes treating a hydrophobic wafer and of adding surfactants (see pages 128, 129 and 402).

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However, Kern has no description of using these chemical solutions as storage water, and of using them for a storage method. For example, it is described on pages 78 and 79 of Kern that the Cu concentration of ultrapure water is 0.01ppb

or less, but Kern has no description of using the ultrapure water as storage water. Also, it is described on pages 30 and 31 of Kern that a chelating solution can be EDTA, but the reference has no description of adding such solution to storage water which is wafer storage water. Although the pages referred to in Kern show the desorption performance of chelating solutions, in order to estimate the desorption performance, the examination is performed by etching the surface of a wafer using radiactive isotopes ^{22}Na or ^{24}Na in NaOH. Thus, Kern clearly assumes that the chelating solutions are used in an etching step. Also, it is described on pages 128, 129 and 402 of Kern that particles are eliminated from a hydrophobic wafer by using a solution, to which is added surfactants, but which is applicable to an etching step or a cleaning step. For example, it is clear from the description on page 402, lines 10 and 11 of Kern that "the use of carefully selected surfactants can significantly reduce the particle contamination in wet etch processing." Also, it is clear from the description on page 402, lines 18 and 19, of Kern that "the hydrophilic/hydrophobic nature of wafer surfaces after various chemical cleaning steps is noted in Table 6(25)." In addition, it is described on page 101, lines 6-8, of Kern that "Nitrogen, argon and vacuum are being used to eliminate or reduce the sources of oxygen and water from the interior surfaces of transfer and storage systems." That is, existence of water in storage systems is disclaimed. Consequently, Kern does not teach that a wafer is stored in water or solution. If anything, Kern teaches to the contrary.

On the other hand, claims 1, 3, 4 and 12 of the present application relate to silicon wafer storage water and a silicon wafer storage method which are used for storing a silicon wafer in water or a solution. That is, conventionally, contamination of a silicon wafer in a cleaning step has been studied (see lines 25-27 of page 2 of the specification). However, even when cleaning is performed, while the concentration of contaminant in the cleaning solution is controlled, in order to produce a silicon wafer having a clean surface, a final wafer that has undergone all processing steps sometimes becomes defective in that its oxide dielectric breakdown voltage is degraded (see lines 11-16 of page 3 of the specification).

In view of this, the present invention involved analysis of the causes of such degradation of oxide dielectric breakdown voltage, and it was found that such degradation is caused by a conventional method of storing a silicon wafer in a step before the cleaning step. Especially, in the case where storage water contains ions of metals, such as copper and silver, having an ionization tendency lower than that of silicon, if the silicon wafer immediately after being subject to polishing and having a hydrophobic surface is stored in the storage water, the quality of an oxide film of the wafer degrades significantly (see lines 5-17 of page 4 of the specification).

In view of the foregoing, the inventors of the present invention conceived of a method of storing a silicon wafer through use of water which contains Cu at a concentration of 0.01 ppb or less in order to prevent degradation of the quality of oxide film of the silicon wafer (see lines 19-23 of page 12 of the specification). The inventors also conceived a method which is prepared through addition of a chelating

agent to water or chemical solution in order to make the above-mentioned ions of metals innocuous or harmless (see lines 4-10 of page 14 of the specification).

On the contrary, Kern has no description of storing a wafer in pure water or water to which is added a chelating agent, and of a problem in the case where a wafer is stored in water and the quality of its oxide film is degraded. Kern merely describes pure water, a chelating solution, or surfactants, but has no description of storing a wafer in water or the like. Thus, Kern has no description or suggestion of the present invention. Therefore, claims such as claims 1, 3, 4 and 12 clearly distinguish patentably over Kern.

The Hayashida reference describes a chelating agent added to an alkaline solution, and the performance of the chelating agent compared with NTA. However, the Hayashida reference relates to a wafer cleaning step, and therefore has no description or suggestion of storing a wafer in water. For example, the subject matter of claims 1-8 thereof relates to a process for treating semiconductor surfaces. Also, it is described at lines 5-8 of column 1 of Hayashida that "this invention relates to a process for treating (or cleaning) surfaces of semiconductors, LCD, etc. with special treating solutions containing a special complexing agent and the treating solutions per se." Moreover, it is described at lines 15-24 of column 3 of Hayashida that "it is an object of the present invention to provide semiconductor surface treating solutions preventing metallic contamination caused by adsorption from a treating solution, having a high cleaning efficiency and overcoming the problems of known alkali surface treating agents mentioned above, and provide a

process for cleaning surfaces of semiconductors..." Hayashida does not describe storing a wafer in water, and in relation to a chelating agent added alkaline solution, it is used only to treat a surface of a wafer.

Therefore, Hayashida merely shows the composition of a chelating solution, and have no description or suggestion that a wafer is stored in water during a waiting period between the polishing step and the subsequent cleaning step, in the manner of the present invention. Hayashida merely describes a chelating agent, which is added to an alkaline solution and performance of the chelating agent compared with NTA, but has no description of storing a wafer in water, or the like. Therefore, Hayashida does not describe or suggest the subject matter of claims 1, 3, 4 and 12 of the present invention. Such claims therefore distinguish patentably over Hayashida.

The Prigge reference describes that wafers may advantageously be preserved by immersion in a bath containing the solution immediately after a polishing step (see lines 20-24 of column 4 of Prigge). However, the reference has no description of specific conditions of the storage water. It merely describes at lines 20-24 of column 4 that "the surface of wafers which have been treated in the first step by means of hydrofluoric acid may advantageously be preserved by immersion in a bath containing the solution selected in the particular case and possibly also thermostated," and in relation to the storage water, Prigge has an ambiguous description of "a bath containing the solution selected in the particular case and possibly also thermostated," but has no description or suggestion of storage water in

the manner of the present invention. That is, Prigge has no description of the case that where storage water contains ions of metals, such as copper and silver, having an ionization tendency lower than that of silicon, the quality of an oxide film of the wafer may degrade significantly. Consequently, storage water as used in the present invention is not disclosed or suggested by Prigge.

In contrast, storage water in accordance with the present invention and as defined in claims 1, 3, 4 and 12, for example, is storage water containing "Cu at a concentration of 0.01 ppb or less" (claims 1 and 4), "water or chemical solution which does not cause degradation of oxide dielectric breakdown voltage due to copper contamination" (claim 3) or "water or a chemical solution containing a chelating agent" (claim 12). These prevent degradation of the quality of an oxide film.

Therefore, Prigge merely describes that wafers may advantageously be preserved by immersion in a bath containing the solution immediately after a polishing step, but there is no description of specific conditions of the storage water. Thus, Prigge has no description or suggestion of the present invention, and claims such as claims 1, 3, 4 and 12 are submitted to clearly distinguish patentably thereover.

Thus, the Kern, Hayashida and Prigge references contain no description or suggestion of the present invention. Even if Kern and Hayashida, which have no description of storing a wafer in water, are combined, the result would not show or suggest the present invention. Moreover, although Prigge has a description of

storing a wafer in water, as described above, such reference does not relate to the case that where storage water contains ions of metals, such as copper and silver, having an ionization tendency lower than that of silicon, the quality of an oxide film of the wafer may degrade significantly. Consequently, one skilled in the art would not attempt to combine Kern with Prigge to use such water for storing wafers. Kern, Hayashida and Prigge have no description of degradation of oxide dielectric breakdown voltage caused by a conventional method of storing a silicon wafer in a step before the cleaning step, and have no suggestion of the problem solved by the present invention. Thus, it would not be possible for one skilled in the art to achieve the present invention by attempting to combine such references. Kern teaches the contrary of the present invention which is storing a wafer in water. The feature in accordance with the present invention is that a wafer is stored in a predetermined storage water. This has the outstanding effect that in the case where a wafer is stored during a waiting period between the polishing step and the subsequent cleaning step, adhesion of polishing slurry which would otherwise occur when the wafer is left in air can be prevented, while preventing degradation of oxide dielectric breakdown voltage of the silicon wafer.

In conclusion, claims 1-20 are submitted to clearly distinguish patentably over the cited references for the reasons discussed above. Therefore, reconsideration and allowance are respectfully requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los

Angeles telephone number (213) 337-6846 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,

HOGAN & HARTSON L.L.P.

Date: December 28, 2000

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